



Department of Transportation
Federal Aviation Administration
Aircraft Certification Service
Washington, D.C.

TSO-C211

Effective
Date: 9/25/17

Technical Standard Order

Subject: *Detect and Avoid (DAA) Systems*

1. **PURPOSE.** This technical standard order (TSO) is for manufacturers applying for a TSO authorization (TSOA) or letter of design approval (LODA). In it, we (the Federal Aviation Administration, (FAA)) tell you what minimum performance standards (MPS) your DAA equipment must first meet for approval and identification with the applicable TSO marking.
2. **APPLICABILITY.** This TSO affects new applications submitted after its effective date.
3. **REQUIREMENTS.** New models of DAA equipment identified and manufactured on or after the effective date of this TSO must meet the MPS qualification and documentation requirements in Section 2 of RTCA Document No. RTCA/DO-365, *Minimum Operational Performance Standards for Detect and Avoid Systems*, dated May 31, 2017, as appropriate to the functional equipment classes listed in Table 1, and paragraph 3.h. The different classes for this TSO are defined by the different functionalities the system provides. Class 1 is the basic DAA system and Class 2 is the basic DAA system with Traffic Alert and Collision Avoidance System (TCAS) II (Version 7.1) functions except for traffic advisories. Each class is further subdivided into several individual articles with corresponding functionalities. Table 1 provides details of the functional equipment classes and articles.

Note: This MPS has been validated for equipment intended to support operations climbing and descending through U.S. Class D, E, and G airspace, enroute to and from Class A airspace, and to and from Special Use Airspace. We have not evaluated the operational suitability of the equipment for extended operations in Class D, E, and G airspace or for transit through Class A, B, and C airspace. Although we are unaware of any safety issues related to its operation in that airspace, changes to equipment operation may be required to maintain air traffic efficiency.

Table 1 – DAA Classes and Articles

Class	Equipment ¹	Criticality		DAA Article Designation ^{2&3}	DAA Equipment Article Name	Function
		Loss of Function	Misleading Information			
1	DAA – Basic	Major	Major	A	Active Surveillance	Air Traffic Control Radar Beacon System (ATCRBS)/Mode S Intruder Detection, TCAS II Mode data, Collision Avoidance coordination data
				B	Unmanned Aircraft (UA) DAA Processor	Track Processing, DAA Alerting ² and Guidance ²
				C	Control Station (CS) DAA Processor	DAA Alerting ² and Guidance ²
				D	CS DAA Control Panel	DAA Mode Control
				E	CS DAA Traffic Display	Display of Traffic, Alerting, and Guidance Information
2	DAA with TCAS II	Major	Hazardous/ Severe Major (See 3.b.(2)(b))	A	TCAS II, Version 7.1	ATCRBS/Mode S Intruder Detection, TCAS II Resolution Advisories (RA) Status and coordination data, Collision Avoidance System Logic, Hybrid Surveillance
				B	UA DAA Processor	Track Processing, DAA Alerting ² and Guidance ²
				C	CS DAA Processor	DAA Alerting ² and Guidance ² with TCAS II Integration
				D	CS DAA Control Panel	DAA Mode Control with TCAS II Integration
				E	CS DAA Traffic Display	Display of Traffic, Alerting, Guidance, and RA Information

Notes:

1. In addition to the articles listed in Table 1, in order for the DAA system to function according to this TSO, both Class 1 and Class 2 Equipment will require the integration of an Air-to-Air Radar for Traffic Surveillance (ATAR) to detect

non-cooperative aircraft and an Automatic Dependent Surveillance-Broadcast (ADS-B) In system to receive ADS-B messages. TSO-C212 provides the MPS for ATAR equipment. TSO-C166b provides MPS for ADS-B In equipment for DAA systems. TSO-C166b equipment used with DAA systems must be Class A, 1090 MHz with receive capability. TSO-C154c equipment may also be used in addition to TSO-C166b Class A equipment. However, TSO-C154c equipment may not be used in place of TSO-C166b Class A equipment because TSO-C154c equipment by itself does not meet the ADS-B detection performance requirements for a DAA system.

2. Articles can be designated both Class 1 and 2 equipment. Articles A and B are installed on aircraft. Articles C, D, and E contain functions that operate remotely on the ground or in a CS, or, for manned aircraft, may be located in the aircraft. Articles B and C contain DAA alerting and guidance functions that are interchangeable on an unmanned aircraft system platform. They may reside either in the UA or in the CS. See Section 5.a.(3) for installation limitations associated with interchangeability and class designations.
3. The requirements for the individual articles are identified in RTCA/DO-365, Appendix O.

a. Functionality. This TSO's standard applies to DAA Class 1 and 2 equipment intended to be used in aircraft operating under Instrument Flight Rules (IFR) to provide alerting and guidance against traffic to remain DAA Well-Clear. In addition, the Class 2 DAA system includes RA capability by integrating a TCAS II System (Version 7.1) without traffic advisories.

Note: DAA Well-Clear is a temporal and/or spatial boundary around the aircraft intended to be an electronic means of avoiding conflicting traffic (see Appendix C in RTCA DO-365 for the quantitative definition).

b. Failure Condition Classifications.

- (1) Loss of the function defined in paragraph 3.a is a major failure condition.
- (2) Failure of the function that causes misleading information is as follows:
 - (a) For Class 1 and Class 2 - *Major* failure condition for malfunctions causing misleading DAA alerting and/or guidance.
 - (b) For Class 2 Only - *Hazardous/severe-major* for un-annunciated failures condition that could generate an incorrect or false TCAS II RA, or result in a missing TCAS II RA.

Note: Advisory Circular (AC) 20-151C, *Airworthiness Approval of TCAS II, Versions 7.0 & 7.1 and Associated Mode S*

Transponders, or later version, provides further guidance for the failure classification of TCAS II systems. RA failure conditions defined in AC 20-151C include missing RA, incorrect RA, and false RA.

(3) Develop the system to, at least, the design assurance level applicable to these failure condition classifications.

c. **Functional Qualification.** Demonstrate the required functional performance under the test conditions specified in RTCA/DO-365, Section 2.4.

d. **Environmental Qualification.** Demonstrate the required performance under the test conditions specified in RTCA/DO-365, Section 2.3 using standard environmental conditions and test procedures appropriate for airborne and ground equipment. You may use a different standard environmental condition and test procedure than those specified in RTCA/DO-365, section 2.3, which includes use of RTCA/DO-160G (for both airborne and ground equipment) and MIL-STD-810G, MIL-STD-704, and RTCA/DO-365, Appendix J (for ground equipment), provided the standard selected is appropriate for the airborne or ground equipment.

Note: The use of RTCA/DO-160D (with Changes 1 and 2 only, without Change 3 incorporated) or earlier versions is generally not considered appropriate and will require substantiation via the deviation process as discussed in paragraph 3.g of this TSO.

e. **Software Qualification.** If the airborne or ground station equipment article includes software, develop the software according to RTCA, Inc. document RTCA/DO-178C, *Software Considerations in Airborne Systems and Equipment Certification*, dated December 13, 2011, including referenced supplements as applicable, to at least the software level consistent with the failure condition classification defined in paragraph 3.b of this TSO. You may also develop the software according to RTCA, Inc. document RTCA/DO-178B, dated December 1, 1992 if you follow the guidance in AC 20-115C, *Airborne Software Assurance*, dated July 19, 2013 or latest revision.

f. **Electronic Hardware Qualification.** If the airborne or ground station equipment article includes complex custom electronic hardware, develop the component according to RTCA, Inc. Document RTCA/DO-254, *Design Assurance Guidance for Airborne Electronic Hardware (AEH)*, to at least the design assurance level consistent with the failure condition classification defined in paragraph 3.b of this TSO. For custom electronic hardware determined to be simple, RTCA/DO-254, paragraph 1.6 applies.

g. **Deviations.** We have provisions for using alternate or equivalent means of compliance to the criteria in the MPS of this TSO. If you invoke these provisions, you must show that your equipment maintains an equivalent level of safety. Apply for a deviation under the provision of 14 CFR § 21.618.

h. Onboard Data Recording Capability. In addition to the performance requirements prescribed under § 2.2.2.2.4 of RTCA/DO-365, the UA DAA processor shall record the target source(s) associated with an intruder (e.g., radar, ADS-B and/or active surveillance) that triggers Guidance Information associated with an alert or results in a DAA Corrective Alert, a DAA Warning Alert, or a TCAS II RA.

4. MARKING.

a. Mark at least one major component permanently and legibly with all the information in 14 CFR § 45.15(b), and include equipment class and article designator, unless the classes and article designator are identified in the installation instructions or by software.

b. If the article includes software and/or electronic hardware, then the article part numbering scheme must identify the software and electronic hardware configuration. The part numbering scheme can use separate, unique part numbers for software, hardware, and electronic hardware.

c. You may use electronic part marking to identify software or electronic hardware components by embedding the identification within the hardware component itself (using software) rather than marking it on the equipment nameplate. If electronic marking is used, it must be readily accessible without the use of special tools or equipment.

5. APPLICATION DATA REQUIREMENTS. You must give the FAA aircraft certification office (ACO) manager responsible for your facility a statement of conformance, as specified in 14 CFR § 21.603(a)(1) and one copy each of the following technical data to support your design and production approval. LODA applicants must submit the same data (excluding paragraph **5.g**) through their civil aviation authority.

a. A Manual(s) containing the following:

(1) Operating instructions and each article limitations sufficient to describe the equipment's operational capability.

Note: RTCA/DO-365 allows some functions to either reside in the CS (ground) or in the airborne equipment. Therefore, the operating instructions and article limitations must clearly identify where the main functions reside to ensure proper compatibility of the DAA equipment to meet the TSO.

(2) Describe in detail any deviations.

(3) Installation procedures and limitations sufficient to ensure that the DAA equipment, when installed according to the installation or operational procedures, still meets this TSO's requirements. Limitations must identify any unique aspects of the installation. Such aspects include, but are not limited to: 1) any limitations on

installation of specific articles to either Class 1 or 2, and UA or ground CS applications; 2) for articles for which DAA Alerting and/or DAA Guidance functionality may reside either in the UA or CS as shown in Table 1, Note 2, identifying whether or not such functionality is provided in the article; 3) any installation compatibility requirements for articles with interchangeable (UA or CS) functionality provisions, to ensure that all functions listed in Table 1 are provided for the DAA Class 1 or DAA Class 2 equipment; and 4) for articles that can be designated both Class 1 and 2 equipment, identifying the class configuration applicability for which installation approval may be given. The limitations must include a note with the following statement:

“This article meets the minimum requirements of TSO-C211. Installation of this article requires separate approval.”

(4) For each unique configuration of software and electronic hardware, reference the following:

(a) Software part number including revision and design assurance level;

(b) Electronic hardware part number including revision and design assurance level; and,

(c) Functional description.

(5) A summary of the test conditions used for environmental qualifications for each component of the article. For example, a form as described in RTCA/DO-160G, *Environmental Conditions and Test Procedures for Airborne Equipment*, Appendix A.

(6) Schematic drawings, wiring diagrams, and any other documentation necessary for installation of the Class 1 DAA or Class 2 DAA equipment.

(7) List of replaceable components, by part number, that makes up the Class 1 DAA or Class 2 DAA equipment. Include vendor part number cross-references, when applicable.

b. Instructions covering periodic maintenance, calibration, and repair, to ensure that the DAA equipment continues to meet the approved TSO design. Include recommended inspection intervals and service life, as appropriate.

c. If the article includes software: a plan for software aspects of certification (PSAC), software configuration index, and software accomplishment summary.

d. If the article includes simple or complex custom electronic hardware: a plan for hardware aspects of certification (PHAC), hardware verification plan, top-level drawing, and hardware accomplishment summary (or similar document, as applicable).

e. A drawing depicting how the article will be marked with the information required by paragraph **4** of this TSO.

f. Identify functionality contained in the article not evaluated under paragraph **3** of this TSO (that is, non-TSO functions). Non-TSO functions are accepted in parallel with the TSO authorization. For those non-TSO functions to be accepted, you must declare these functions and include the following information with your TSO application:

(1) Description of the non-TSO function(s), such as performance specifications, failure condition classifications, software, hardware, and environmental qualification levels. Include a statement confirming that the non-TSO function(s) do not interfere with the article's compliance with the requirements of paragraph **3**.

(2) Installation procedures and limitations sufficient to ensure that the non-TSO function(s) meets the declared functions and performance specification(s) described in paragraph **5.f.(1)**.

(3) Instructions for continued performance applicable to the non-TSO function(s) described in paragraph **5.f.(1)**.

(4) Interface requirements and applicable installation test procedures to ensure compliance with the performance data defined in paragraph **5.f.(1)**.

(5) Test plans and analysis, as appropriate, to verify that performance of the hosting TSO article is not affected by the non-TSO function(s).

(6) Test plans and analysis, as appropriate, to verify the function and performance of the non-TSO function(s) as described in paragraph **5.f.(1)**.

g. The quality manual required by 14 CFR § 21.608, including functional test specifications. The quality system must ensure that you will detect any change to the approved design that could adversely affect compliance with the TSO MPS, and reject the article accordingly. Applicants who currently hold TSOAs must submit revisions to the existing quality manual as necessary (not required for LODA applicants.)

h. A description of your organization as required by 14 CFR 21.605.

i. Material and process specifications list.

j. List of all drawings and processes (including revision level) that define the article's design.

k. Manufacturer's TSO qualification report showing results of testing accomplished according to paragraph **3.c** of this TSO.

6. MANUFACTURER DATA REQUIREMENTS. Besides the data given directly to the responsible ACO, have the following technical data available for review by the responsible ACO:

- a. Functional qualification specifications for qualifying each production article to ensure compliance with this TSO and compatibility with each article.
- b. Article calibration procedures.
- c. Schematic drawings.
- d. Wiring diagrams.
- e. Material and process specifications.
- f. The results of the environmental qualification tests conducted according to paragraph 3.d of this TSO.
- g. If the article includes software, the appropriate documentation defined in RTCA/DO-178B or RTCA/DO-178C as specified in paragraph 3.e of this TSO, including all data supporting the applicable objectives in Annex A, *Process Objectives and Outputs by Software Level*.
- h. If the article includes complex custom electronic hardware, the appropriate hardware life cycle data in combination with design assurance level, as defined in RTCA/DO-254, Appendix A, Table A-1. For simple custom electronic hardware, the following data: test cases or procedures, test results, test coverage analysis, tool assessment and qualification data, and configuration management records, including problem reports.
- i. If the article contains non-TSO function(s), you must also make available items 6.a through 6.h as they pertain to the non-TSO function(s).

7. FURNISHED DATA REQUIREMENTS.

- a. If furnishing one or more articles manufactured under this TSO to one entity (such as an operator or repair station), provide one copy or on-line access to the data in paragraphs 5.a and 5.b of this TSO. Add any other data needed for the proper installation, certification, use, or for continued compliance with the TSO, of the DAA equipment.
- b. If the article contains declared non-TSO function(s), include one copy of the data in paragraphs 5.f.(1) through 5.f.(4).
- c. If the article contains software, provide one copy of the Open Problem Report (OPR) summary to type certification, supplemental type certification, or amended type

certification design approval holders or applicants seeking installation approval of the TSO.

8. HOW TO GET REFERENCED DOCUMENTS.

a. Order RTCA documents from RTCA Inc., 1150 18th Street NW, Suite 910, Washington, D.C. 20036. Telephone (202) 833-9339, fax (202) 833-9434. You can also order copies online at www.rtca.org.

b. Order copies of 14 CFR parts 21, 91, and 45 from the Superintendent of Documents, Government Printing Office, P.O. Box 979050, St. Louis, MO 63197. Telephone (202) 512-1800, fax (202) 512-2104. You can also order copies online at bookstore.gpo.gov.

c. Order copies of Military Standards (MIL-STD) from DLA Document Services, Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, or from the ASSIST Customer Service Desk, telephone (215) 697-6396. You can also search online at <http://quicksearch.dla.mil>.

d. You can find a current list of technical standard orders and advisory circulars on the FAA Internet website Regulatory and Guidance Library at <http://rgl.faa.gov/>. You will also find the TSO Index of Articles at the same site.



Louis R. Volchansky
Manager, Systems & Equipment Standards Branch
Policy & Innovation Division